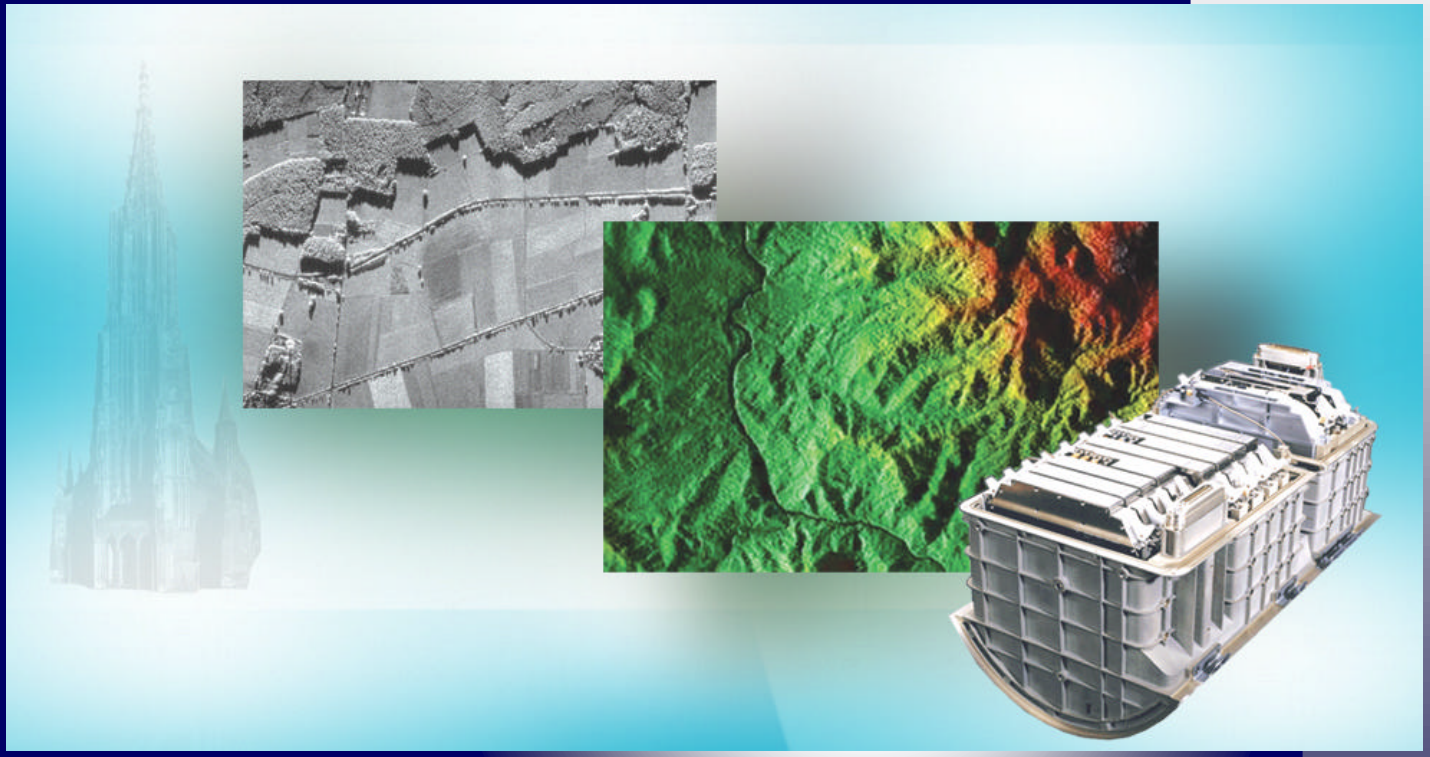
Airborne Systems

SAR for UAVs: Status, Technologies, Trends



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UAV 2002 Conference, Paris, 14 June

EADS Deutschland GmbH
Airborne Systems
Radar

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
02 SEP 2003	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
SAR for UAVs: Status, Technologies, Trends	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **EADS Deutschland GmbH Airborne System**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001676, UAV 2002 conference & Exhibition., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**27**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

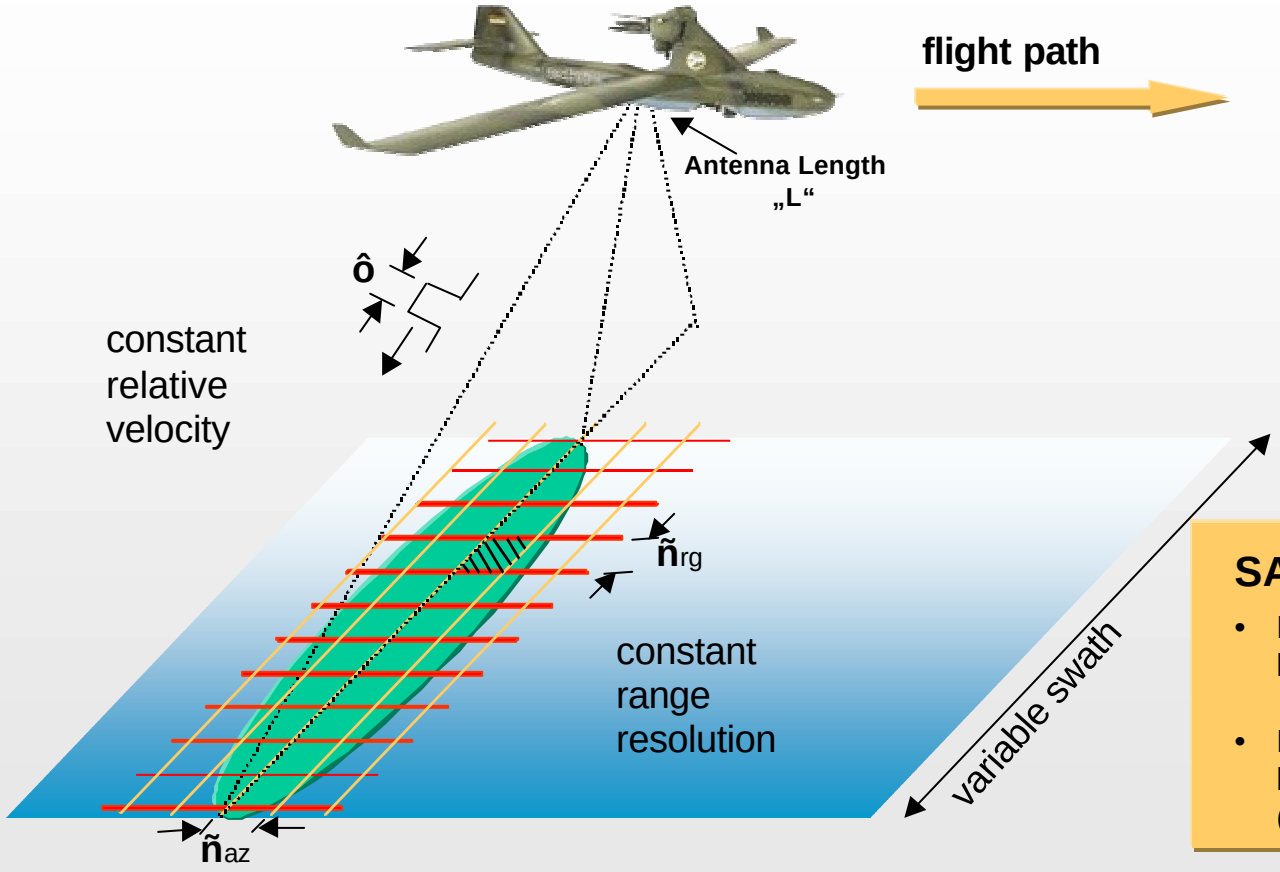
SAR for UAVs: Status, Technologies, Trends

Contents

- Introduction to SAR
- SAR Applications
- SAR Data Flow
- SAR Imaging, Multi-Mode SAR Benefits and Examples
- Operational Requirements,
  Performance Overview: Status, Trends
- New Generation SAR/MTI Sensor (SOSTAR-X)
- Technology Overview: Status, Trends

- MISAR, a mini SAR for TUAVs from EADS

SAR Stripmap Mode



SAR Resolution

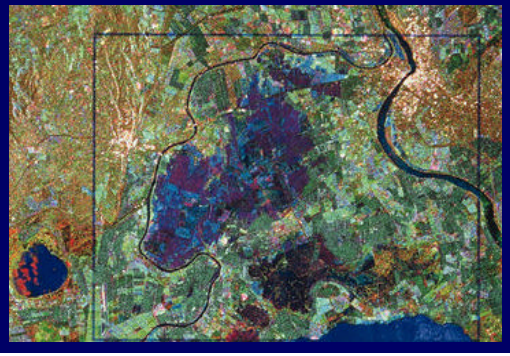
- Resolution across-track $\tilde{n}_{rg} = c * \hat{O}/2$ by high range resolution
- Resolution along-track $\tilde{n}_{az} = L/2$ by high resolution of relative velocity (doppler frequency)

SAR Applications

SAR operates as an all-weather, day and night sensor, capable of penetrating cloudes, rain, smoke and fog

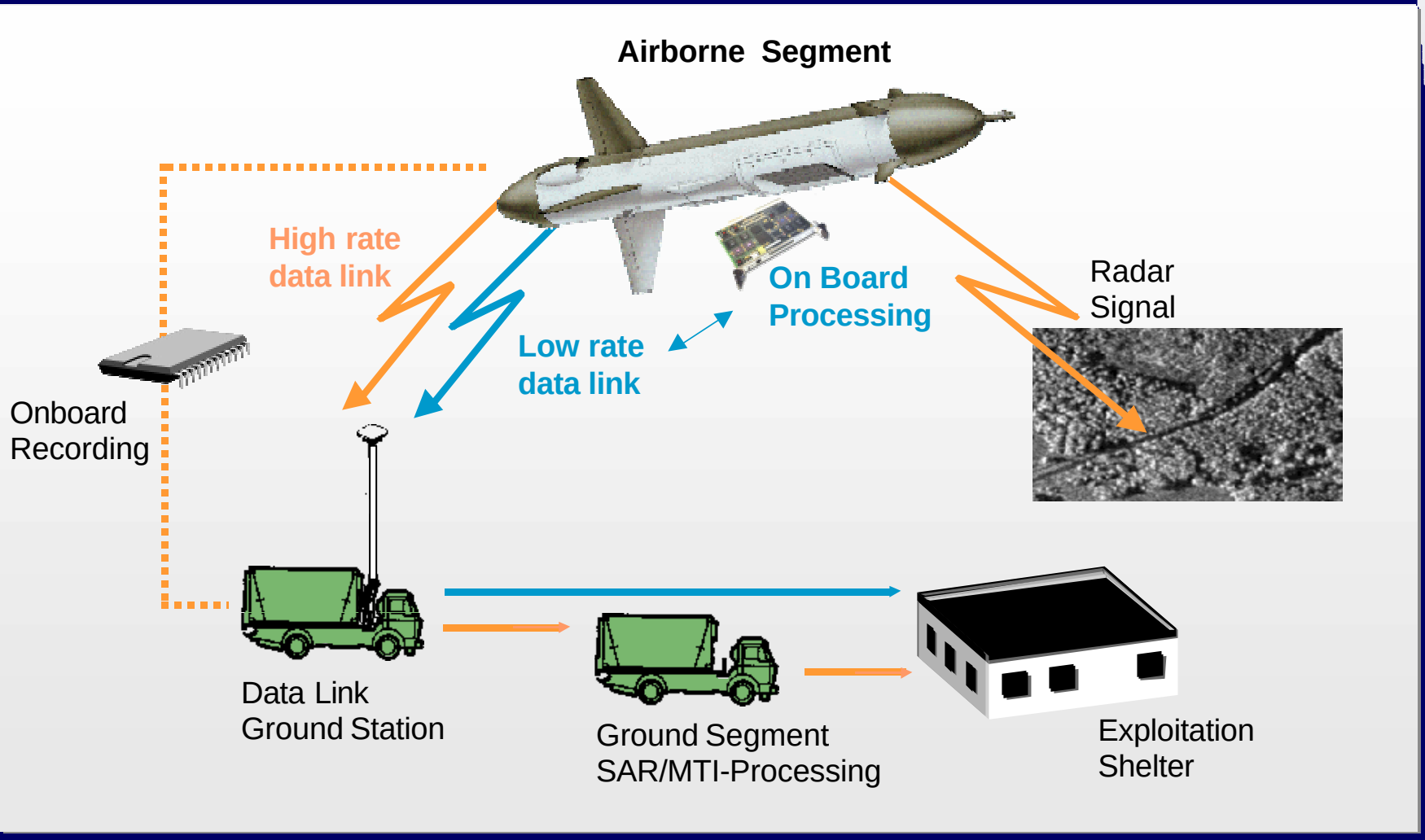
Applications, e.g.:

- **Surveillance and Reconnaissance**
  - SAR imaging, moving target identification (MTI)
  - Lenght measurement, target classification
  - Sea and border control
  - Thematic mapping, terrain contour mapping, area classification
- **Environmental Monitoring**
  - Pollution and forest control
  - Erosion and landslip control
  - Damage assessment, flooding and earth-quake monitoring



Flood after bursting of a dam

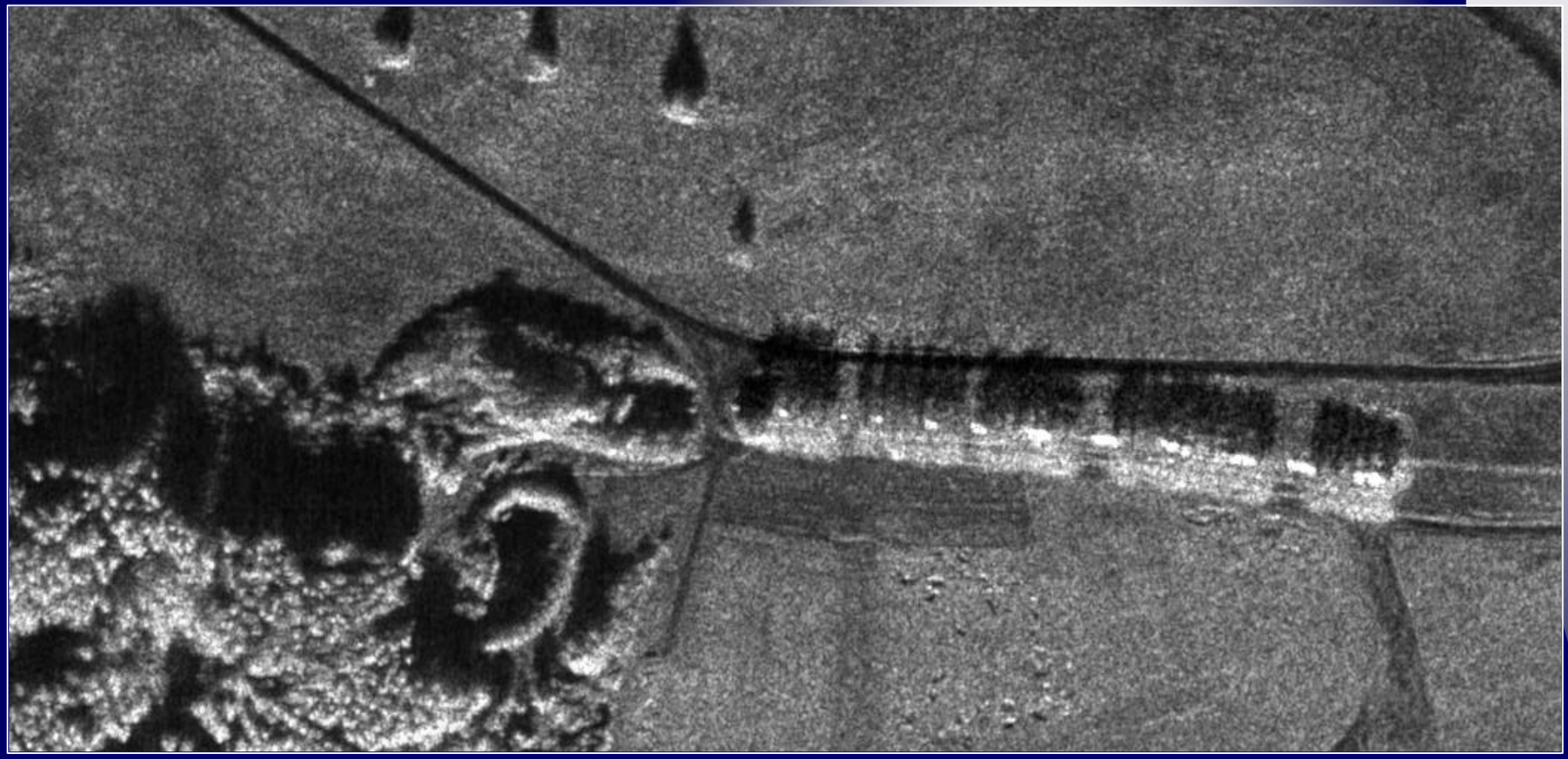
SAR Data Flow



SAR Imaging

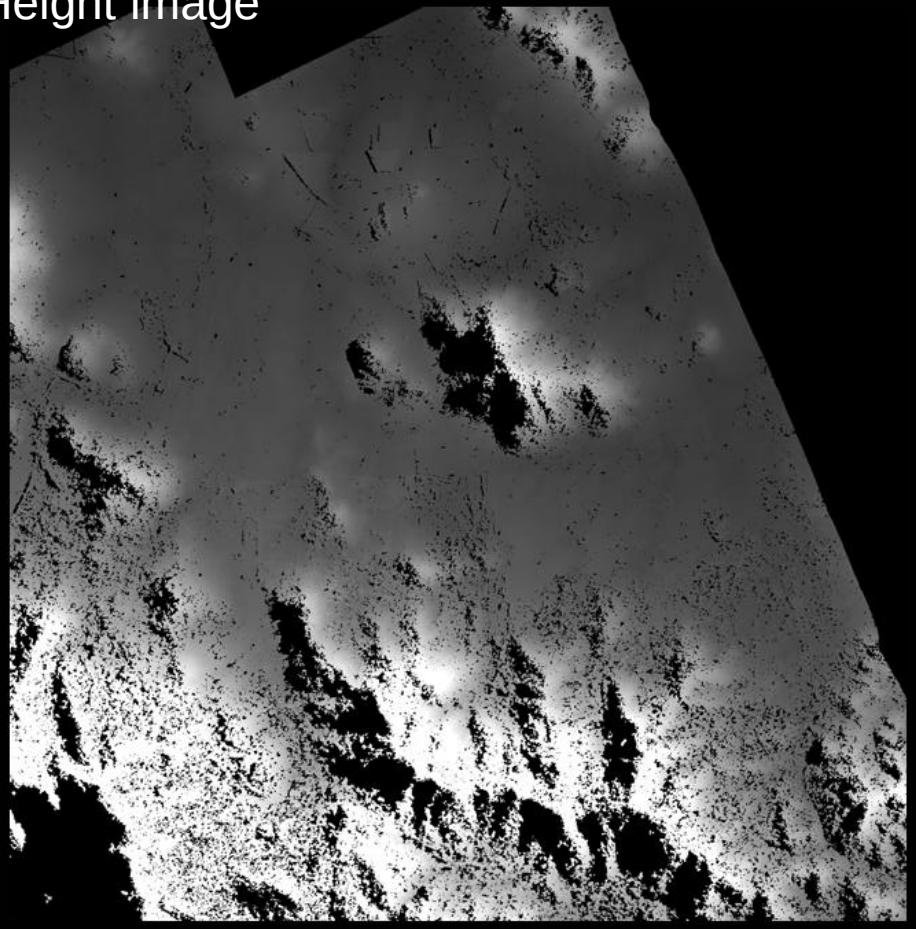
SAR Imaging

Convoy „hiding“ beneath a row of trees

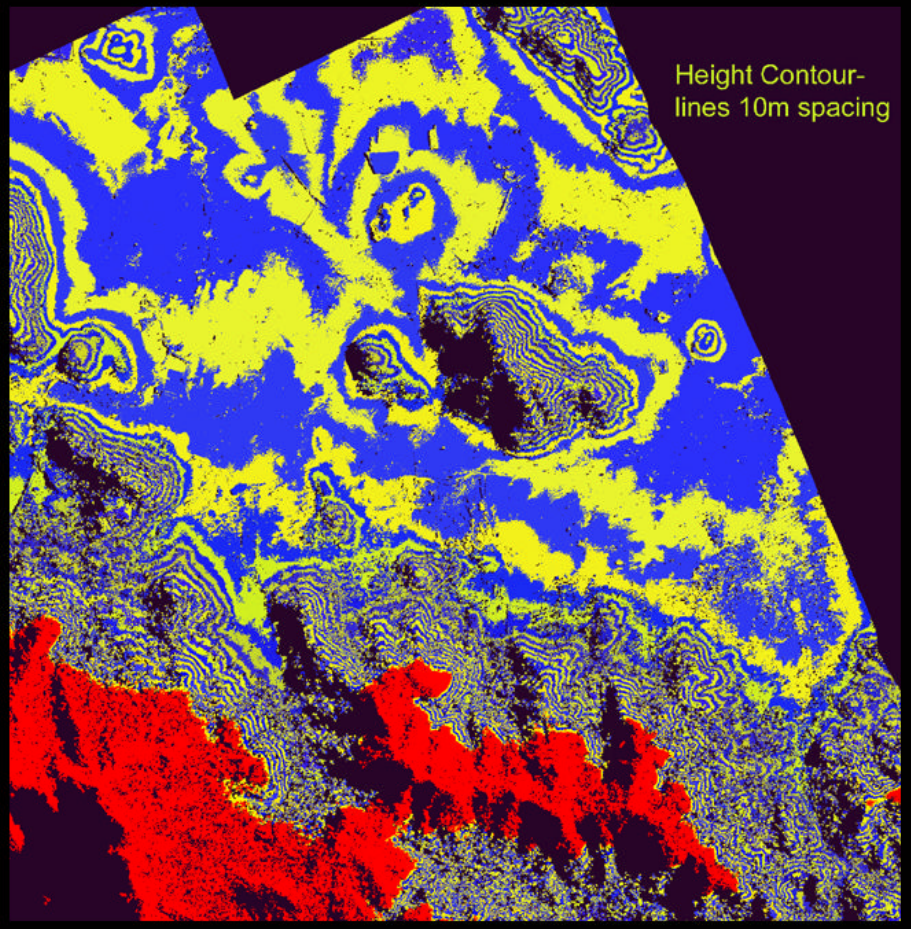


SAR Imaging

Height image



Grayscale



Height contour lines 10 m spacing

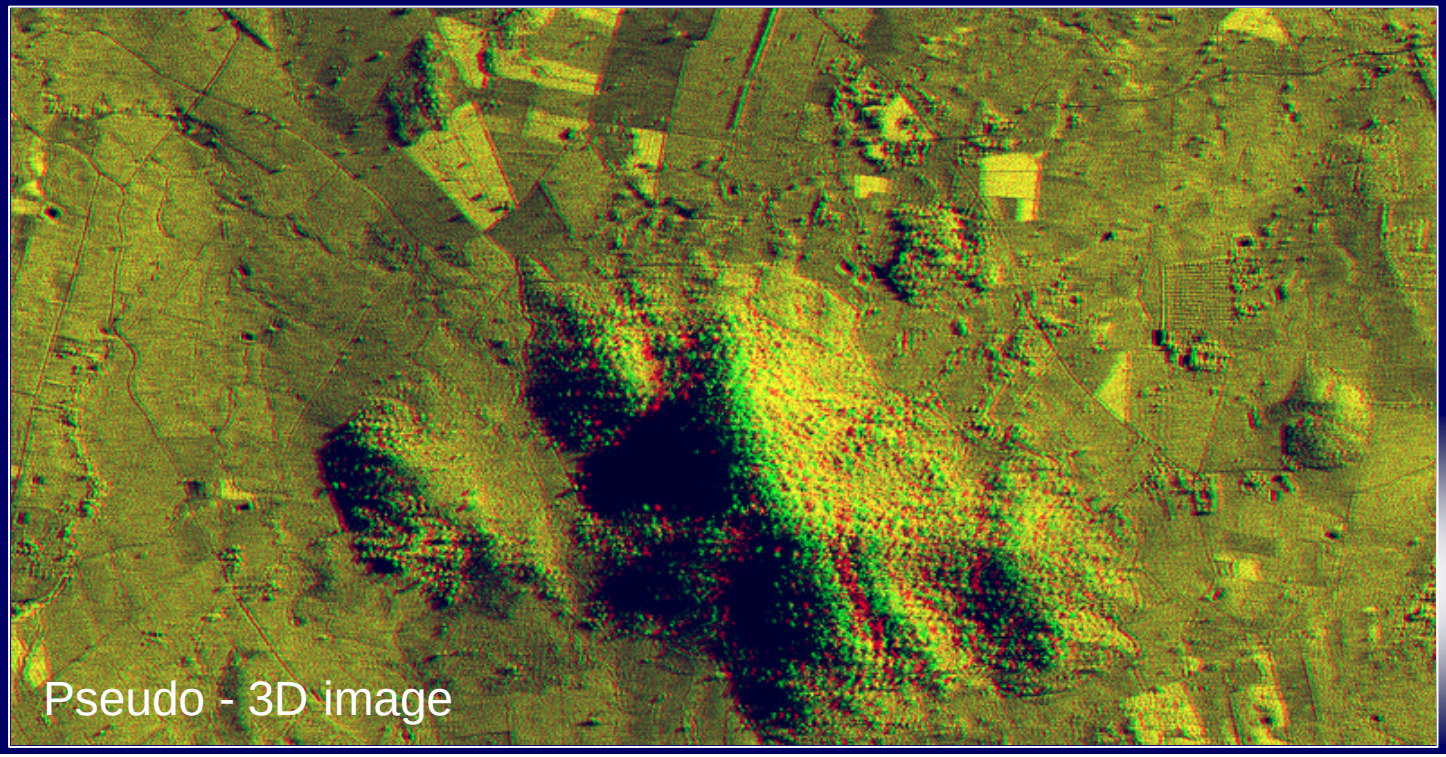
IFSAR

Interferometric SAR

Pseudo 3D images can be generated either by using two antennas located some distance from each other or by flying two passes of a UAV with one antenna

Benefit

Provides terrain elevations over large areas and is therefore inportant for UAV guidance. In addition: Generation of accurate surface profile maps



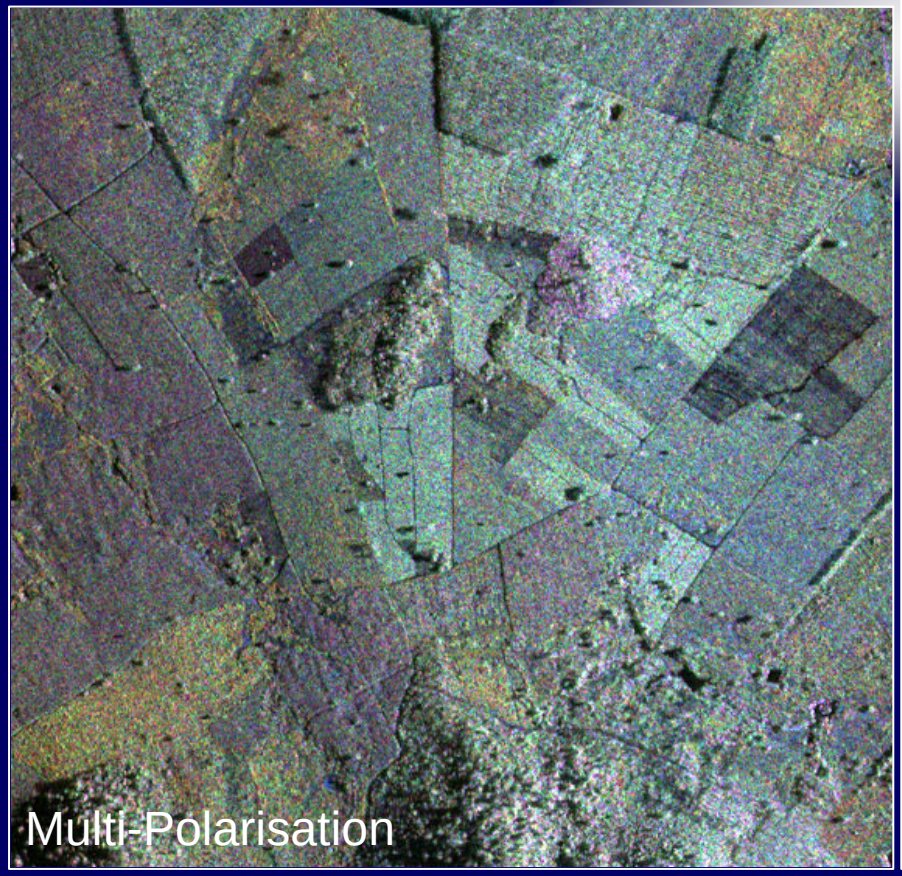
Pseudo - 3D image

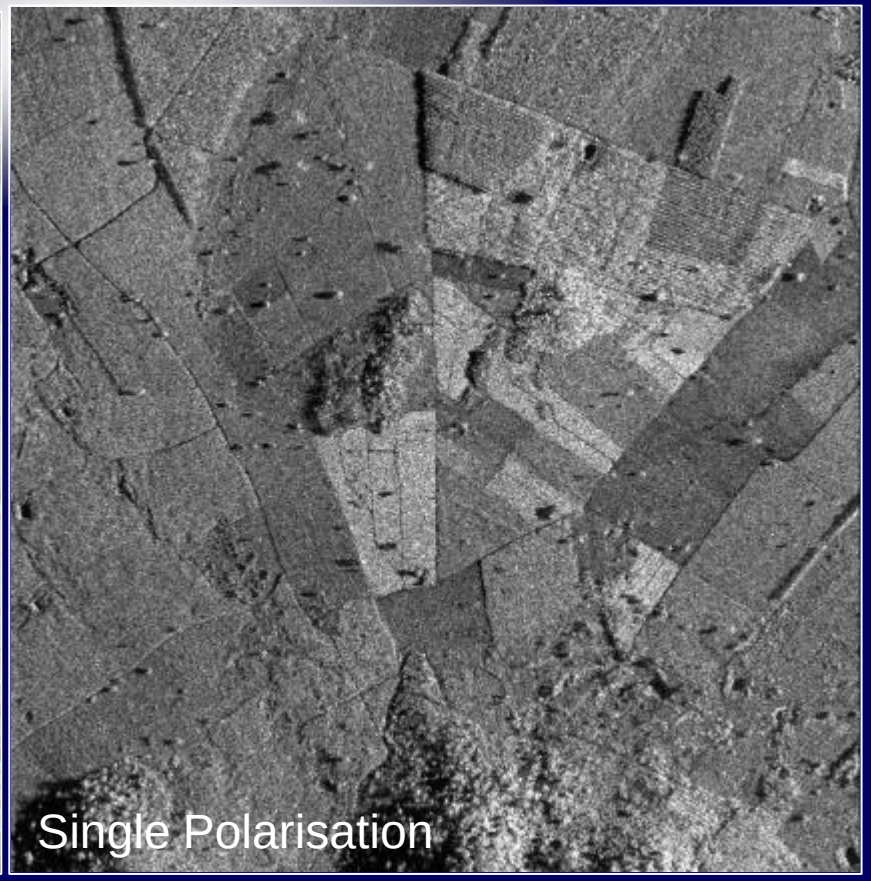
Multi-Polarisation SAR

SAR transmits and receives vertical and horizontal polarised signals (VV, VH, HH, HV)

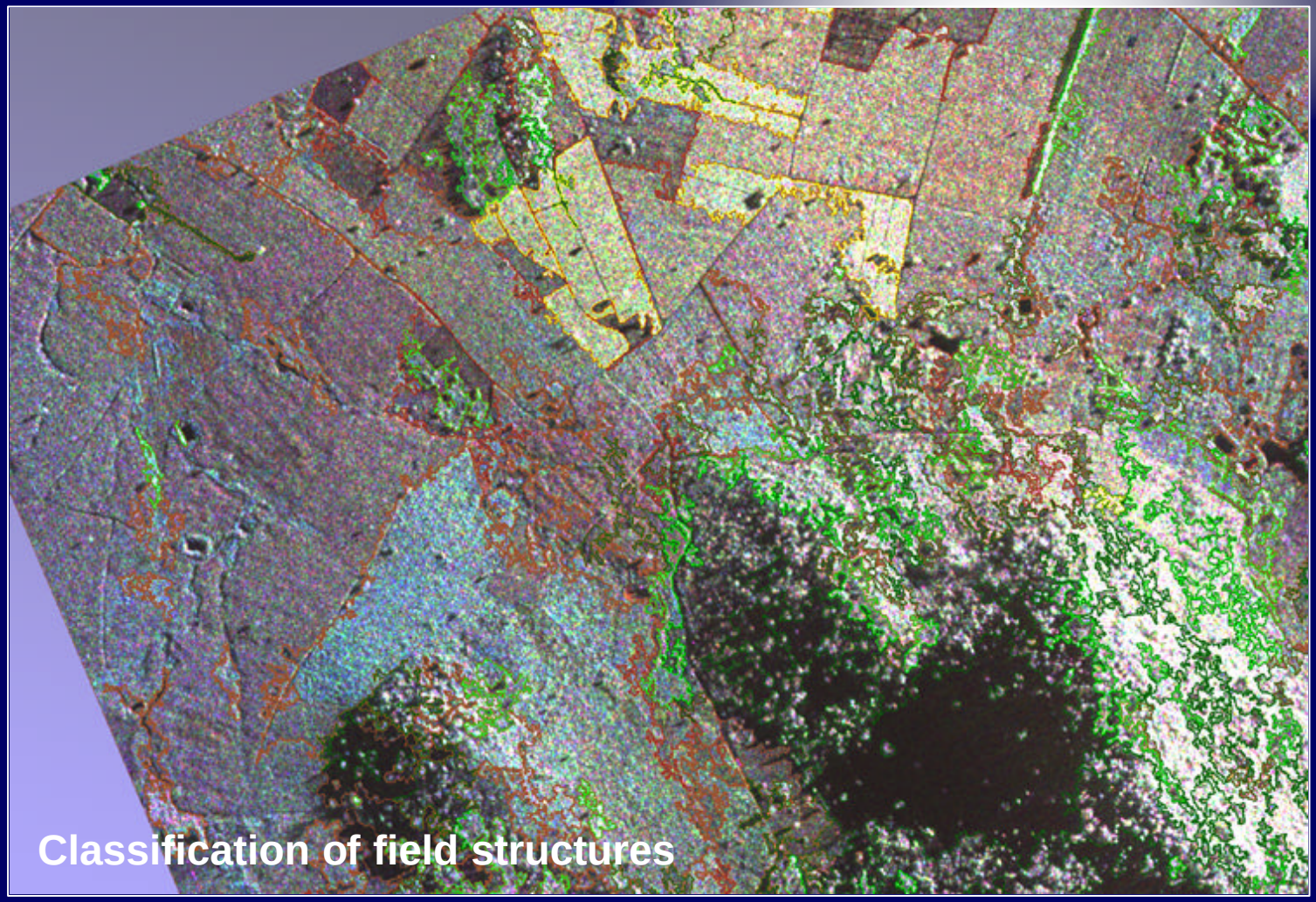
Benefit

e.g. ground classification





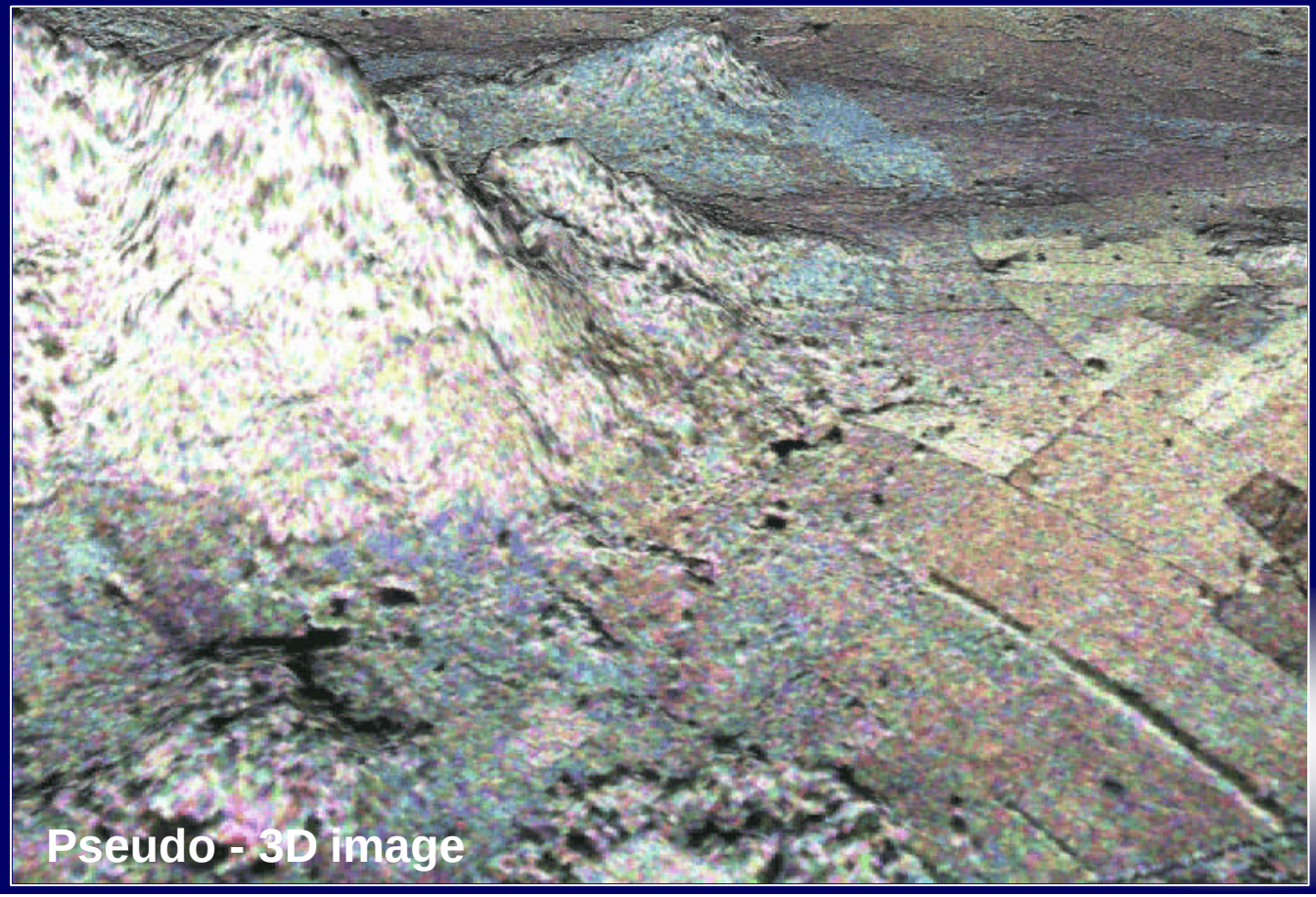
Multi - Polarisation SAR



Combination of 3D Image and Multi-Polarisation SAR

Benefit

Combined generation of surface profiles and ground classification



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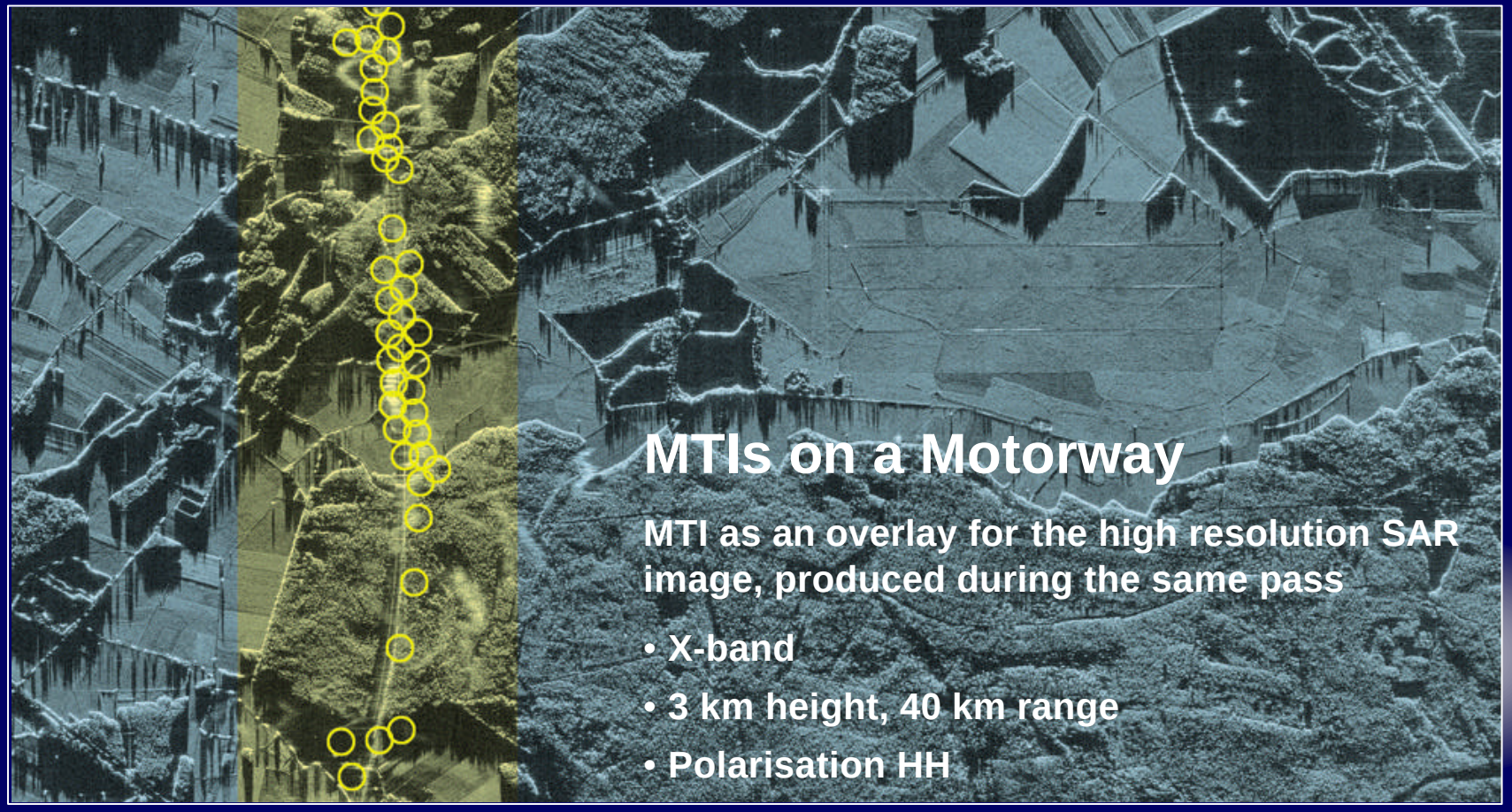
Combined, Simultaneous SAR/MTI Image

Benefit

Moving targets can be inserted simultaneously into the SAR images



SAR Operational Requirements and Performance Overview

Status, Trends Example: SAR for TUAVs

Requirements and Performance		Status (typ.)	Trends (typ.)
Physical characteristics	• **Weight**	30 ... 160 lbs	< 10 ... 100 lbs
	• **Power**	200 ... 1200 W	< 100 ... 500 W
Operational characteristics	• **Ground speed**	30 … 250 m/sec	partially up to 0.95 mach
	• **Range (SAR/MTI)**	5 ... 30 km (in weather)	partially > 40 km
	• **Real time SAR-image processing**	on board/on ground	mainly on board
	• **Moding**	SAR Strip Map SAR Spot-Light MTI	+ partially simultaneous or interleaved operation modes **(multi-mode)**
Performance	• **Swath width**	800 m ... 1800 m	> 2,000 m
	• **Resolution**	1 ft ... 3 ft	0.5 ... 1.5 ft

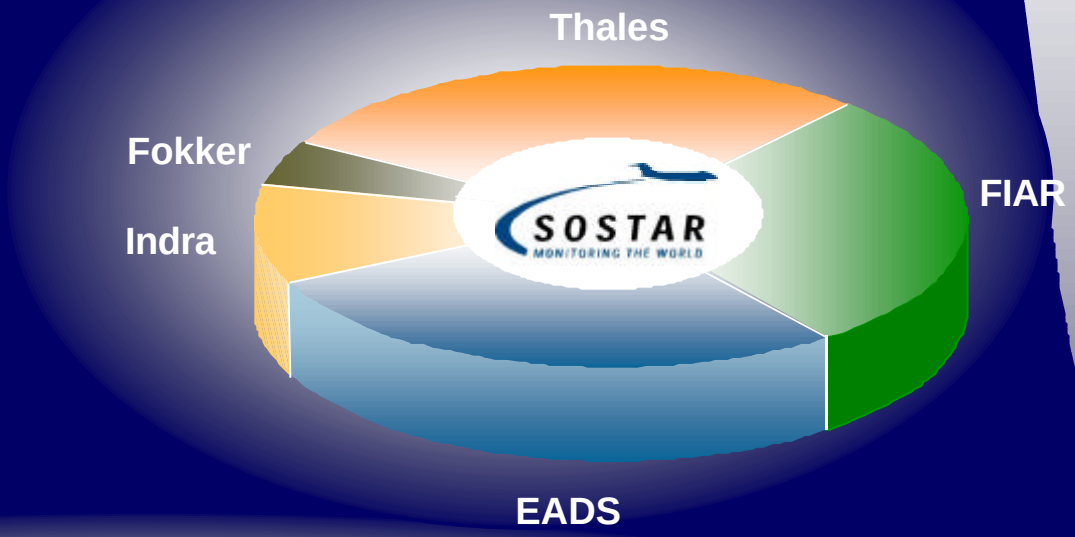
SOSTAR - X

(**S**tand-**O**ff **S**urveillance and **T**arget **A**cquisition **R**adar)

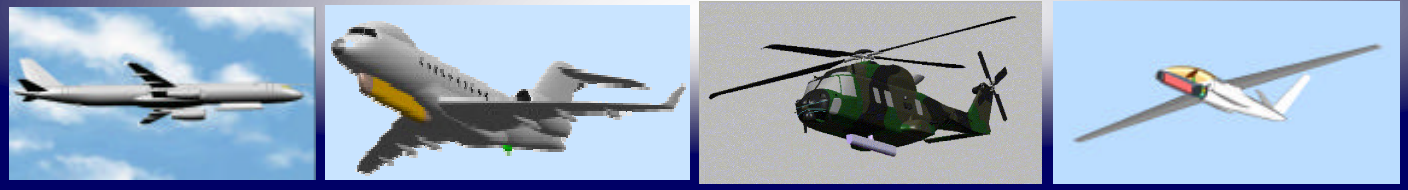
Demonstrator Program for AGS with a new generation SAR/MTI, e.g.

- MTI for Wide Area Surveillance
- Surveillance Swath SAR
- High Resolution Swath
- MTI Fast Sector Scan
- Mid Range Spot SAR
- Long Range Spot SAR
- MTI Classification Mode
- ISAR

  etc.



Platforms

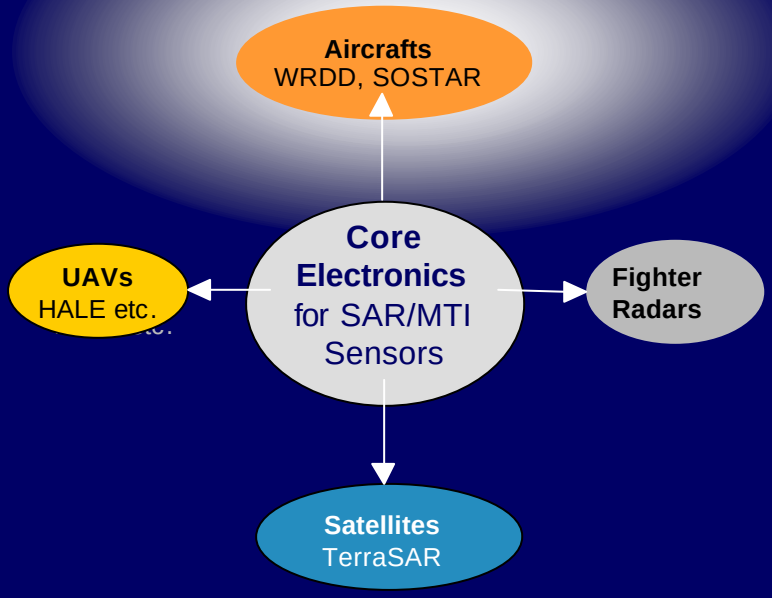


Technology: SAR Core Electronics

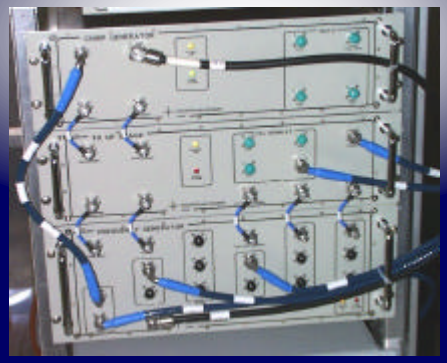
Common Functions

- Tx Signal Generation (chirp generation, up-conversion)
- Rx Signal Demodulation, Digitisation, Formatting
- Sensor Control and Frequency Generation

Applications



Technologies



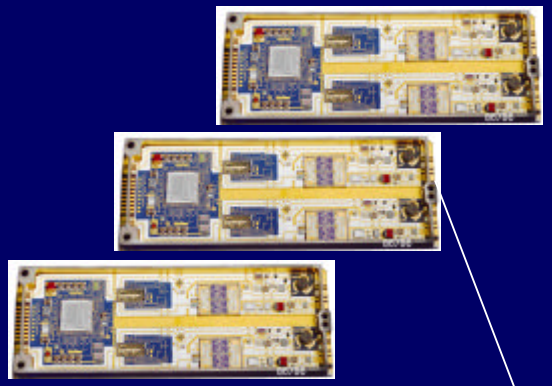
Chirp Generation

Up-Conversion

Frequency Generation

Currently scaling down of the components for application on UAVs and satellites

Technology: Antenna Components



T/R Module

Beam Steering Computer Elements

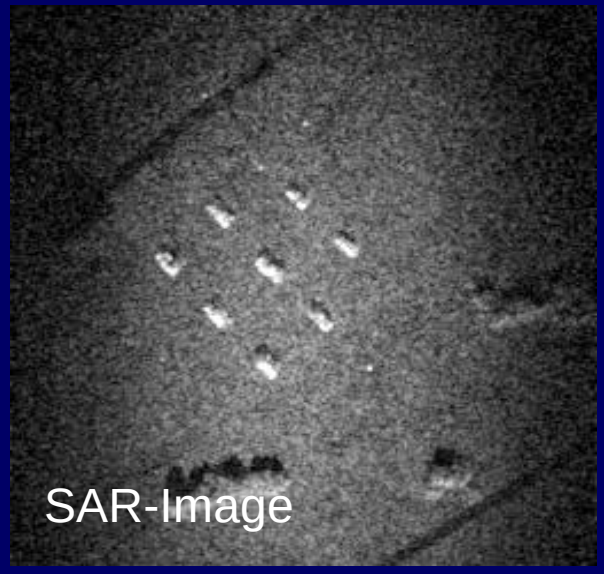
Array Power Supplies

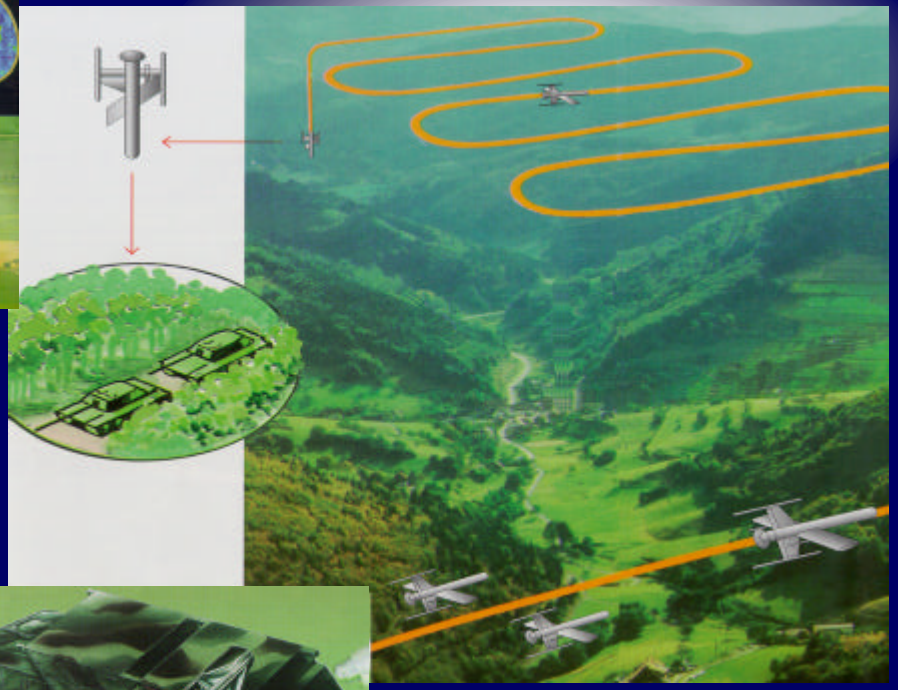
RF Converter

Cooling for array and electronics

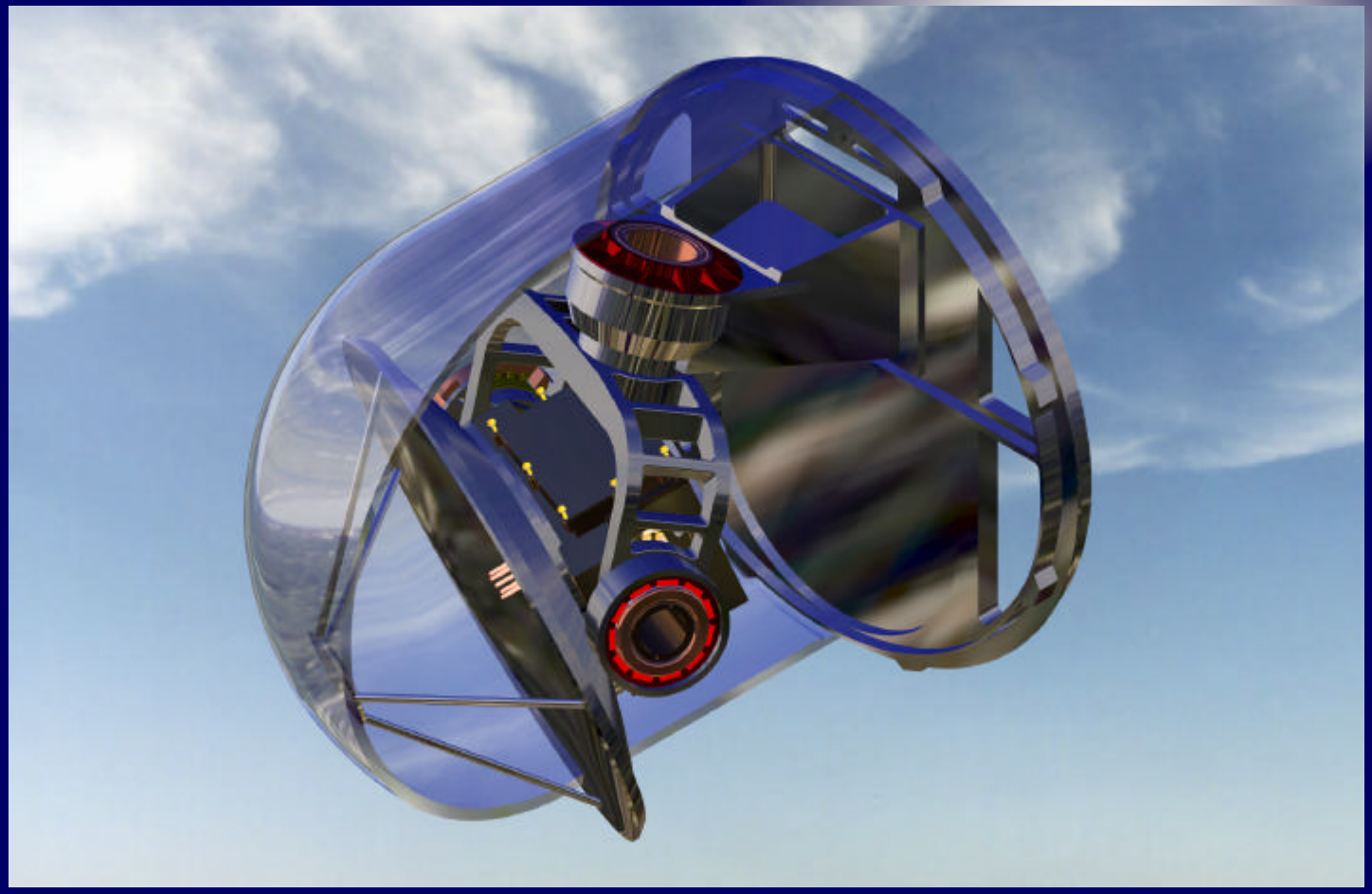
Inertial Navigation Unit

SAR Seeker German Army Combat Drone





Antenna on Gimbal

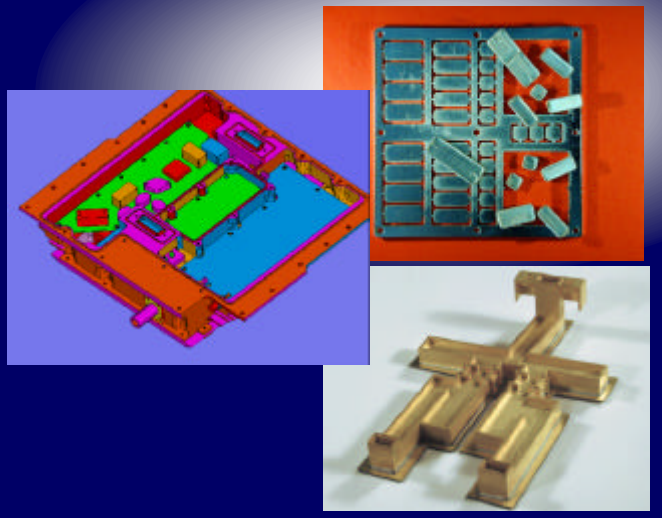


Advanced mmW Technologies

High precision plastic casting

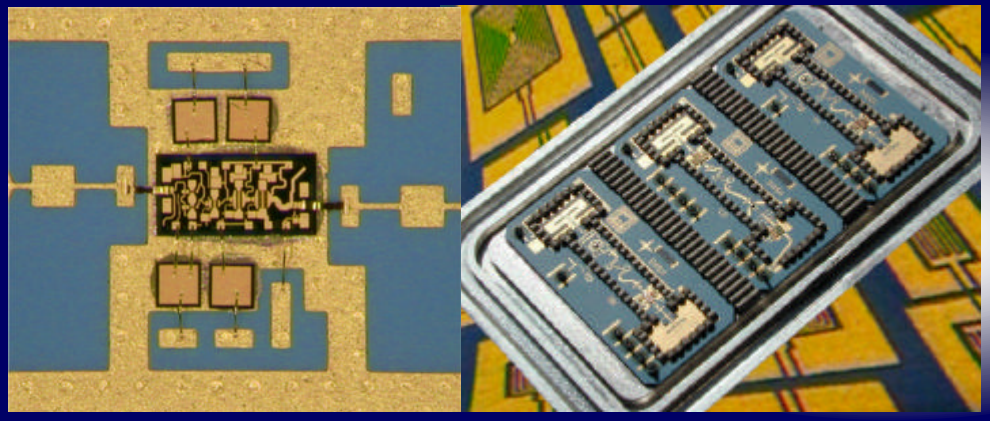
- mechanical structures
- housing, covering plate, wave-guide

Advantage: reduced mass, “low cost”

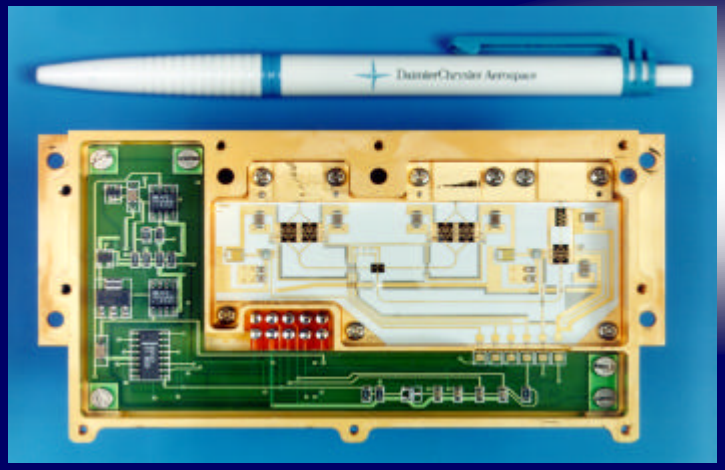


LTCC (low temperature cofired ceramics)

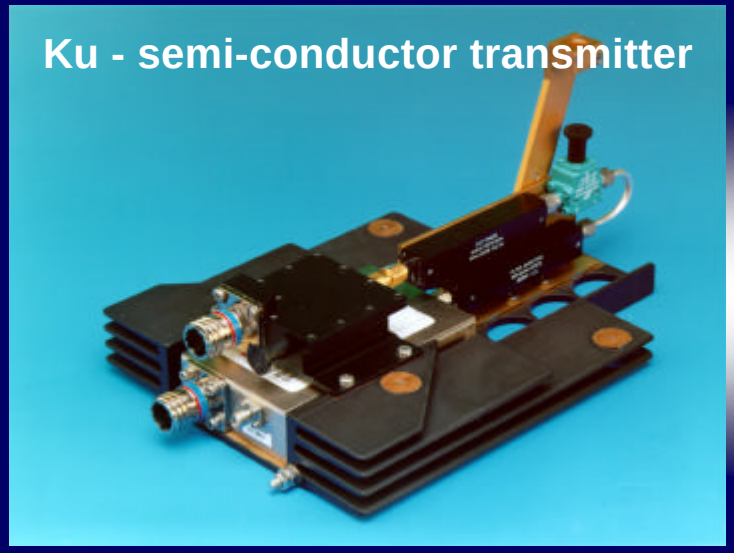
- highly integrated mmW multi-layers
- realisation of planar and three-dimensional structures

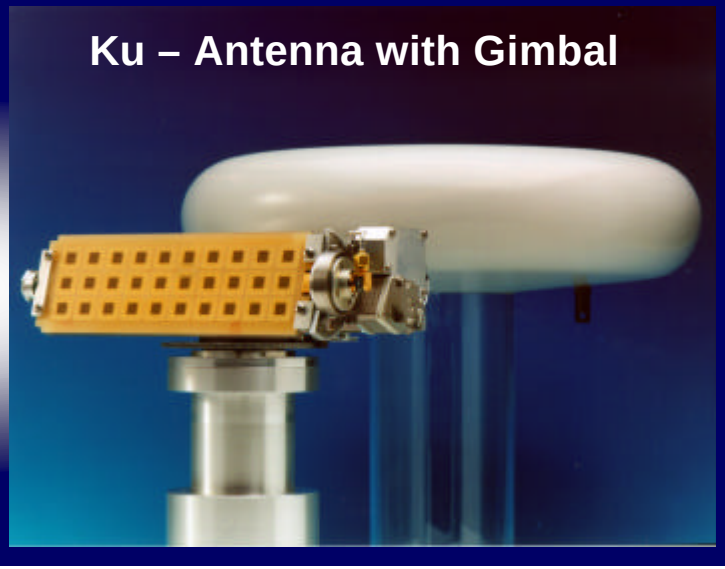


mmW Technology Examples

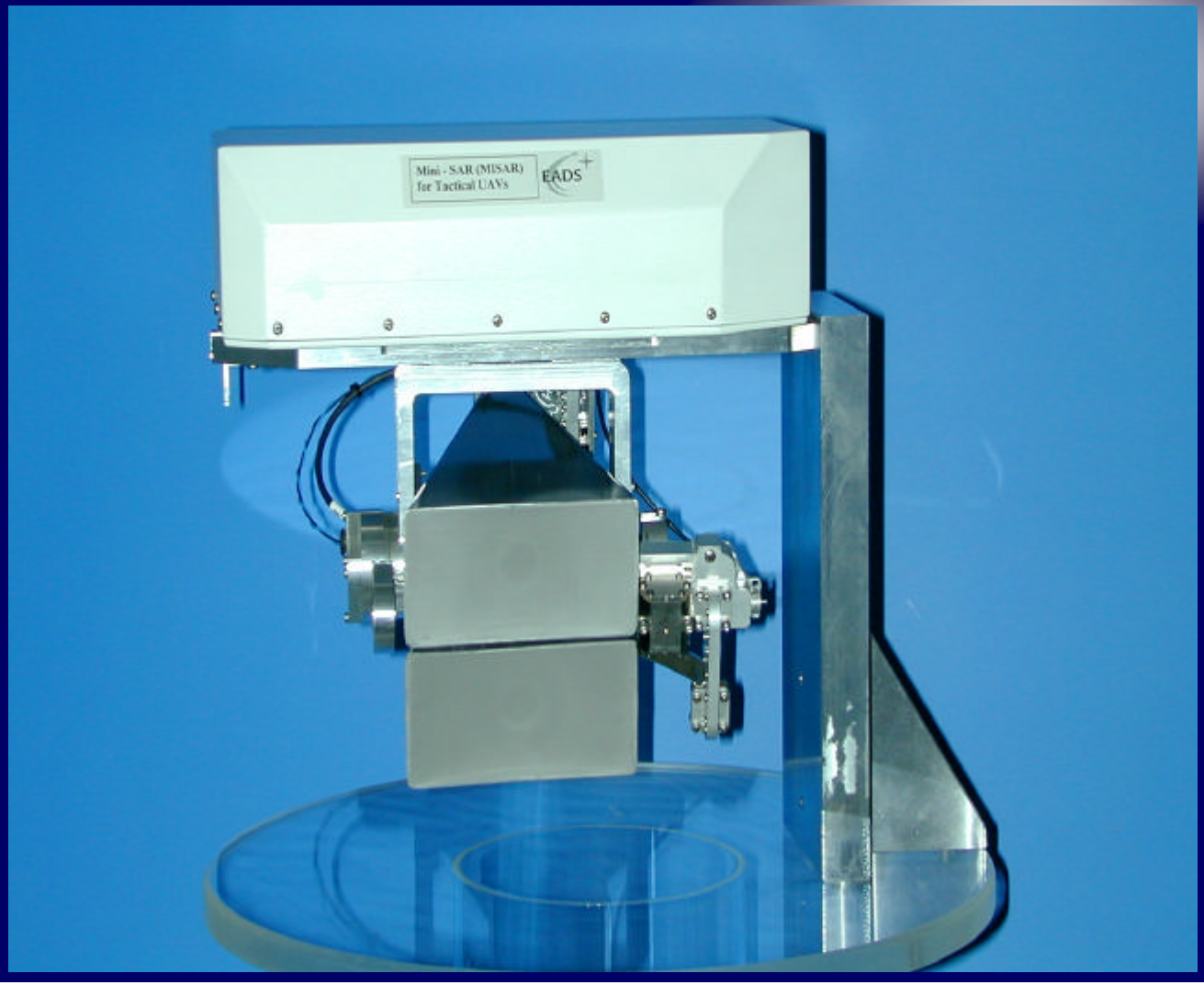


Ka - Transmitter Amplifier





MISAR Model



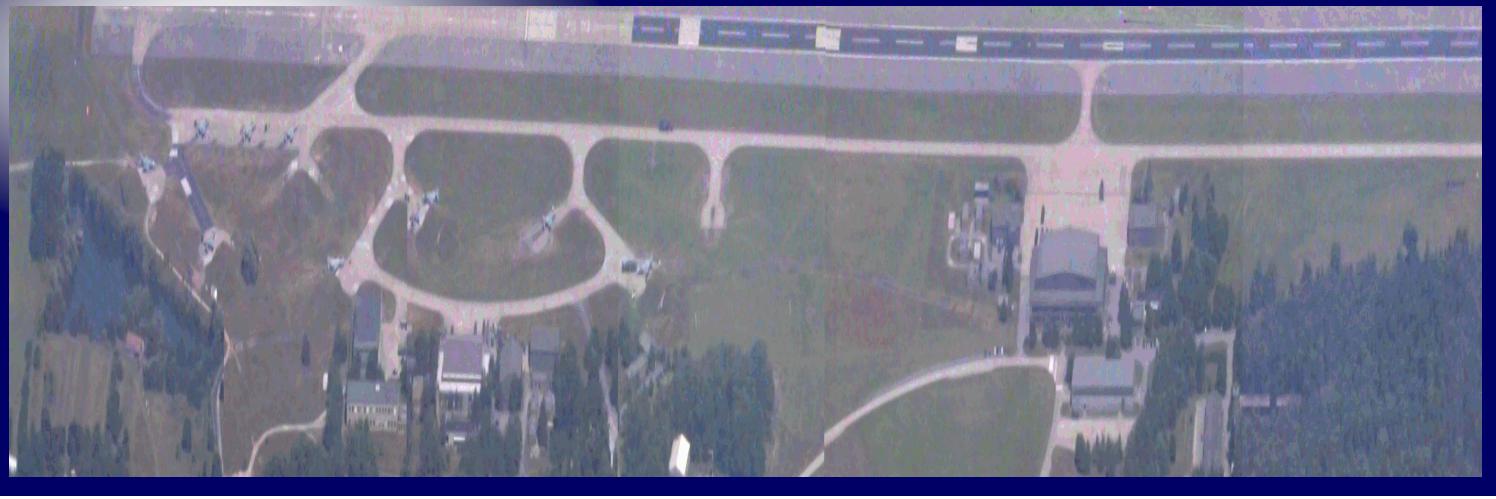
MISAR Model

Technical Data MISAR

• Resolution	0.5 m
• Swath	500 m ... 2000 m
• Frequency	Ka-Band
• Power Consumption	< 50 W
• Weight	< 4 kg
• Volume	< 4 l

SAR-Image Airstrip Zone I

SAR-Image



Video-Image

Summary MISAR

- SAR-Imagery for UAV with mmW-technology possible
- MISAR deliverable end of this year based on developed seeker for GERMAN Combat Drone
- EADS SAR-sensors easy to modify according to UAV payload specification
- Dedicated for low weight (4 ... 15 kg) / low volume (4 ... 50 l) payloads
- Mature with MTI-Mode